the greater part of the motion, is large relatively to the frictional resistance of the suspended mass.

Between ordinary earthquakes and tremors, on the one hand, capable of observation by the inertia method, and slow earth-tiltings, on the other, capable of observation by the equilibrium method, it is at least possible that there may be many movements, not reducible to either type. For example, if successive upheaval and subsidence of small amplitude were to occur with a very long horizontal wave-length, and with a period of (say) one or two minutes or more, it would be practically impossible even to detect its existence by either of the methods named, unless by chance it were repeated several times with uniform period in the presence of a very frictionless vibrator whose free period happened to agree nearly with the period of the disturbance; even then, no measurement of its amount could be made. We are in fact forced to classify earth-movements under the two heads which have been named, not because there is any necessary discontinuity between the two, but because they must be treated by two entirely distinct modes of observation.

For the measurement of palpable earthquakes by the inertia method, the writer has devised many instruments which have been successfully applied to the registration of Japanese earthquakes, and which are described in a memoir on earthquake measurement, published in 1883 by the University of Tokio. He has not attempted in any case to give the astatically suspended mass three degrees of freedom, and nothing would be gained by doing so. An instrument with two degrees of freedom is now exhibited to the Association. It consists of an ordinary pendulum coupled with an inverted pendulum, in such a manner that the two bobs move together in any horizontal direction. This combination of a stable with an unstable mass can be adjusted to give any desired degree of astaticism. In practice it is convenient to allow the joint mass to have a free period of from five to ten seconds, the period of ordinary earthquake waves being much less than this. A long and light lever, pivoted to the frame of the instrument at one point, and to the steady mass at another, forms a registering index, by which a magnified trace of the earth's horizontal movement is deposited on a fixed plate of smoked glass with the least possible friction.

In another instrument two components of horizontal motion are separately determined, each by a horizontal pendulum, tilted slightly forwards to give a small degree of stability, and furnished with a multiplying pointer. In this instrument the pointers trace the successive movements of the earth on a plate of smoked glass which is kept revolving uniformly by clockwork. The velocity and acceleration of the movements are deducible from the records. This is the standard form of seismograph employed by the writer, and, to make the information it gives complete, another instrument for registering (on the same plate) the vertical motion of the ground is added.

The vertical-motion seismograph is a horizontal lever, supported on a horizontal fixed axis, and carrying at one end a heavy mass. A spring attached to a fixed point above holds up the lever by pulling on a point near the fulcrum. To make the mass nearly astatic the point at which the spring's pull is applied is situated below the horizontal line of the lever, so that when the spring, by (say) being lengthened, pulls with more force, the point of application moves nearer the fulcrum, and the moment of the pull remains very nearly equal to the moment of the weight.

Apart from its application to palpable earthquakes the inertia method is to be applied to minute earth-tremors of the kind observed in Italy by Bertelli and Rossi, which are probably to be found wherever, and whenever, one searches for them with sufficient care. But in dealing with them no mechanical means of recording can well be applied, on account of its friction, and a still more frictionless method of suspending the heavy mass is desirable. The writer prefers for this purpose a mode of suspension based on Tchebicheff's approximate straight-line motion; and to detect the movement of the ground he observes, by a microscope fixed rigidly to the frame of the machine, the displacement of the frame with respect to the suspended mass. This is Bertelli's method, except for the substitution of a nearly astatic mass for the stable mass used by him—namely, the bob of a short pendulum—which of course gives a misleading magnification of certain vibrations.

The writer was recently requested by the Directors of the Ben Nevis Observatory to design seismometers for use there, and obtained a Government grant for their construction. The equipment at Ben Nevis will include recording-seismographs, and a micro-seismometer of the kind just described. To measure slow earth-tiltings an instrument is being constructed in which a modification (due to Wolf) of d'Abbadie's arrangement (described in Prof. Darwin's Reports) is followed. Light from a lamp travels some twenty feet horizontally to a mirror inclined at 45° to the horizon. It passes vertically down through a lens which brings the rays into parallelism. They then strike two reflecting surfaces—one the surface of a basin of mercury, the other a plane mirror very rigidly fixed to the rock. The rays come back to form two images near the source, and any relative displacement of the two images is measured by a micrometer-microscope. In the choice and design of this instrument the writer has to acknowledge much assistance from Prof. G. H. Darwin. This apparatus, like the others, was intended for Ben Nevis, but a visit to the Observatory there has convinced the writer that to use it on that site, and in the atmosphere which prevails on the top, would be a matter of extreme difficulty, and that, in the first instance at least, observations should be made with it on lower ground.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. P. G. Tait has been elected an Honorary Fellow of Peterhouse; and Mr. T. T. Jeffery, M.A., a Fellow of the same College.

Mr. J. Larmor, M.A., of St. John's College, has been appointed one of the University Lecturers in Mathematics, and also Examiner for the First Part of the Mathematical Tripos of 1886.

The Syndicate appointed to re-arrange the additional subjects of the Previous Examination have reported in favour of adding Elementary Dynamics to Statics, and reducing the Trigonometry to what is needed for the Examination in Mechanics; Mathematical Honour students, they recommend, shall no longer be required to pass this Examination, but instead be required to pass in either French or German. Physical Science and Biology are still to receive no recognition even as optional subjects.

Dr. Burghardt, Lecturer in Mineralogy in Owens College, Manchester, is appointed to examine in Mineralogy in the Natural Sciences Tripos; Prof. Ray Lankester, F.R.S., to examine in Zoology and Comparative Anatomy in the same Tripos, the First M.B., and the Special Examinations.

Christ's College offers Scholarships and Exhibitions for Natural Science, the Examination beginning January 5, 1886. The Examinations at Jesus College begin on the same day.

The Special Boards for Physics and Chemistry and for Biology and Geology have issued the following notice with regard to the First Part of the Natural Sciences Tripos:—

In Part I. of the Examination all the questions will be of a comparatively elementary character, and will be such as to test a knowledge of principles rather than of details. Specimens may be exhibited for description and determination.

In Physics the questions will be limited to the elementary and fundamental parts of the subject, and, in particular, special attention will be paid to the definition of physical quantities, the general principles of measurement, the configuration and motion of a material system, the laws of motion, the comparison of forces and of masses, and the properties of bodies. In Sound, Light, Heat, Electricity and Magnetism, only the fundamental laws, their simpler applications, and the experiments which illustrate them, will be required.

In Chemistry the questions will relate to the leading principles and experimental laws of Chemistry, the properties of the commoner elements and their principal compounds, the outlines of Metallurgy, and simple qualitative and quantitative analysis.

In Mineralogy the questions will be confined to elementary Crystallography, the general properties of minerals and the special characters of those species only which are of common occurrence or of well-known mineralogical importance.

In Geology the questions will be limited to Physical Geography, the interpretation of the structure of the crust of the earth and the history of its formation, so far as to involve only the elementary parts of Palæontology and Petrography.

In Botany the questions will relate to the elementary parts of Vegetable Morphology, Histology, and Physiology; and to the principles of a natural system of classification as illustrated by the more important British natural orders. Candidates will be required to describe plants in technical language. Questions

will not be set on Vegetable Palæontology or the Geographical Distribution of Plants.

In Zoology and Comparative Anatomy minor details will not be included in the questions relating to classification. Geographical distribution of animals is held to be a part of Zoology, and Comparative Anatomy includes the structure of extinct as well as of recent forms.

Human Anatomy will include the mechanism of the human body, the comparison of its parts with those of lower animals, its development, &c. ; but the questions will be of a simple and elementary character.

In Physiology the questions will be of a comparatively elementary character.

A practical examination will be held in each of the above subjects.

SCIENTIFIC SERIALS

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Zürich, August 7-9, 1883.—We note here the opening address by Prof. Cramer, on unicellular fungi.

Verhandlungen der Naturhistorischen Vereines der preussischen Rheinlande, Westfalens, und der Reg-Bezirks Osndrück, 42nd year, first half, 1885.—The greensand of Aacken and its mollusan fauna, by J. Böhm.—The forest vegetation of the outer North-western Himalaya, by D. Brandis.—On Devonian Aviculaceæ, by O. Follmann.— The biology of water plants, by H. Schenck.

Nouveaux Mémoires de la Societé Helvetique des Sciences Naturelles, vol. xxix. part 1, 1884 —Geological sections of the Tunnels of Doubs, by M. Mathay.— On the nisal flora of Switzerland, by M. Heer. Fossil woods from Greenland, by M. Beust.

SOCIETIES AND ACADEMIES

London

Mathematical Society, November 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers, Balliol College, Oxford, was elected a member.—The following gentlemen were elected to form the Council for the ensuing Session :— President : J. W. L. Glaisher, F.R.S. ; Vice-Presidents : Dr. O. M. Henrici, F.R.S., Prof. Sylvester, F.R.S., J. J. Walker, F.R.S. ; Treasurer : A. B. Kempe, F.R.S. ; Secretaries : M. Jenkins, R. Tucker ; other Members of the Council : Prof. Cayley, F.R.S., Sir J. Cockle, Knt., F.R.S., E. B. Elliott, A. G. Greenhill, J. Hammond, H. Hart, C. Leudesdorf, Capt. P. A. Macmahon, R.A., Samuel Roberts, F.R.S.—The following communications were made :—On waves propagated along the plane surface of an elastic solid, by Lord Rayleigh, F.R.S.—On the application of Clifford's graphs to ordinary binary quantics, by A. B. Kempe, F.R.S. (Messrs. Hammond and Macmahon put questions to the author).—On Clifford's theory of graphs, by A. Buchheim.—On unicursal curves, by R. A. Roberts.—On some consequences of the transformation formula $y = \sin (L + A + B + C + . -)$, by J. Griffiths.

Linnean Society, November 5.—Sir John Lubbock, Bart., President, in the chair.—Mr. T. Christy exhibited orchids of the genus *Catasetum*, showing that owing to the plants having been moved, the flower in both instances had become malformed.—Mr. E. A. Heath showed a golden eagle in its characteristic plumage of the second year.—Mr. J. Carter exhibited a collection of seeds, lately introduced, remarkable for their peculiarities as specimens under the microscope.—There was shown for the Baron von Mueller a collection of skeleton leaves of species of *Eucalyptus*, prepared by Mrs. Lewellin of Melbourne. These confirm Baron von Mueller's observations as to definite layers, and the relation of these to the skeletonising process. The leaves in decaying produce no bad odour. Von Mueller's observations do not support M. Rivière's statement that the bamboo is as good as eucalypts to subdue malaria ; the former dry up, but do not exhale volatile oil as do the latter, and the eucalypts moreover absorb moisture as quickly as Willows, Poplars, and Bamboos.—Dr. Ondaatje showed examples of walking-sticks from Ceylon palms, viz. the Kittool Palm (*Cayota urens*), the Areca and Cocoa-nut.—Mr. J. G. Baker made remarks on an exhibition by Mr. Thiselton Dyer of Darwin's potato (*Solanum meglia*), grown at Kew, the weight of twelve tubers being 28 oz. ; also the "papa de Oso," Bear's potato (*S. tuberosum*, var.), grown out of doors from tubers received from Dr. Ernst of Caracas, who obtained them from Merida, where they are found wild.—Then followed a paper, viz. contributions to the flora of the Peruvian Andes, with remarks on the history and origin of the Andean flora, by Mr. John Ball. In this paper the author says that his statements chiefly refer to the western slope of the Cordilleras. From the collections made and other data, so far, therefore, a this region of Peru is concerned, it may confidently be averre that the limit of Alpine vegetation has been placed by previous writers on the subject far too low. In the present instance there can be no serious error as to heights, seeing these are based on those of the railway engineers. The explanation of this relatively high extension of the temperate flora depends on the peculiar climatical conditions. Rain occurs but sparingly, the nights are cold, but frost scarcely known ; whereas in the plateau region eastward storms, heavy snow, and frosts are frequent The vegetation of the region visited Mr. Ball divides into a subtropical dry zone from coast to 8000 feet, a temperate zone reaching to 12,500 feet, and an Alpine zone upwards to 17,000 feet, above the sea-level. As regards the proportion in which the natural families of plants are represented in the Andean flora, the Compositæ amount to nearly one-fourth of the whole species, the grasses equal one-eighth, the Scrophularineæ supply five per cent., while Cruciferæ, Caryophylleæ, and Leguminosæ each are represented by about one-thirtieth of the whole. The Cyperaceæ are conspicuous by their absence ; a remarkable feature is the presence of four Crassulaceæ. If we take the proportions of the endemic genera and species as criteria, then, as far as materials admit, the Andean flora appears to be one of the most distinct existing in the world. Mr. Ball agrees with those who think it probable that the south polar lands constitute a great archipelago of islands. To this region in question he is inclined to refer the origin of the Antarctic types of the South American flora.—The first part of an exhaustive monograph on recent Brachiopoda, by the late Dr. Thos. Davidson, was read by the Secretary. In this part of his contribution the author reviews the labours of his predecessors in the field, with regard to the shell, to the anatomy of the adult, and to the embryology. As regards the perplexing question of affinities he remarks :—"Now, although I do not admit the Brachiopoda to be worms, they may, as well as the Mollusca and some other groups of invertebrates, have originally diverged from an ancestral vermiform stem, such as the remarkable worm-like mollusk *Neomenia* would denote." He lays stress on the brachiopodous individual being the product of a single ovum, and not giving rise to others by gemmation. He considers that the shell, the pallial lobes, the intestine, the nerves, and the atrial system, afford characters amply sufficient to define the class. The greatest depth at which a living species has been found alive has been 2990 fathoms. As to classification, he groups the recent species into two great divisions :—(1) Anthropomata (Owen) = Clistenterata (King), (2) Lypomata (Owen) = Tretenterata (King). The Anthropomata he groups in 3 families :—1st Fam. Terebratulaceæ, with 7 sub-families and 13 genera and sub-genera, 70 species, and 21 uncertain species. 2nd Fam. Thecideidæ, with 1 genus and 2 species. 3rd Fam. Rhynchonellidæ, 1 genus, 1 sub-genus, and 8 species. The Lypomata he also groups into 3 families, 5 genera and sub-genera, 23 species, and 7 uncertain species :—1st Fam. Craniidæ, with 1 genus and 4 species. 2nd Fam. Discinidæ, with 1 genus, 1 sub-genus, and 8 species. 3rd Fam. Lingulidæ, with 1 genus and 1 sub-genus, and 11 species. He does not concur with M. Delongchamps' scheme (1884) of classifying the Terebratulina, bringing forward Mr. Dall's observations on *Waldheimia floridana*, of delicate spiculæ in the floor of the great sinuses as telling evidence against the arrangement. Dr. Davidson then proceeds to treat of the various genera and species, adding remarks in detail on the Terebratulaceæ from his standpoint, and throughout gives copious descriptions and observations on each.

Royal Microscopical Society, October 14.—The Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited D'Arsonval's water microscope, a suggestion for improving the means of focusing. The body-tube of this extraordinary instrument contained a glass cylinder which was connected by an india-rubber tube with a syringe. On turning the handle of the syringe water was forced into the cylinder, and the focus was altered according as more or less water was pumped in. Of course, an alteration of focus did result from the operation, but the arrangement destroyed the correction of the objective, and was